Integrated Optic Chemical Sensor for Simultaneous Detection & Quantification of Multiple Ions

Developer: Physical Optics Corporation
Contract Number: DE-AR21-95MC32111
Crosscutting Area: CMST

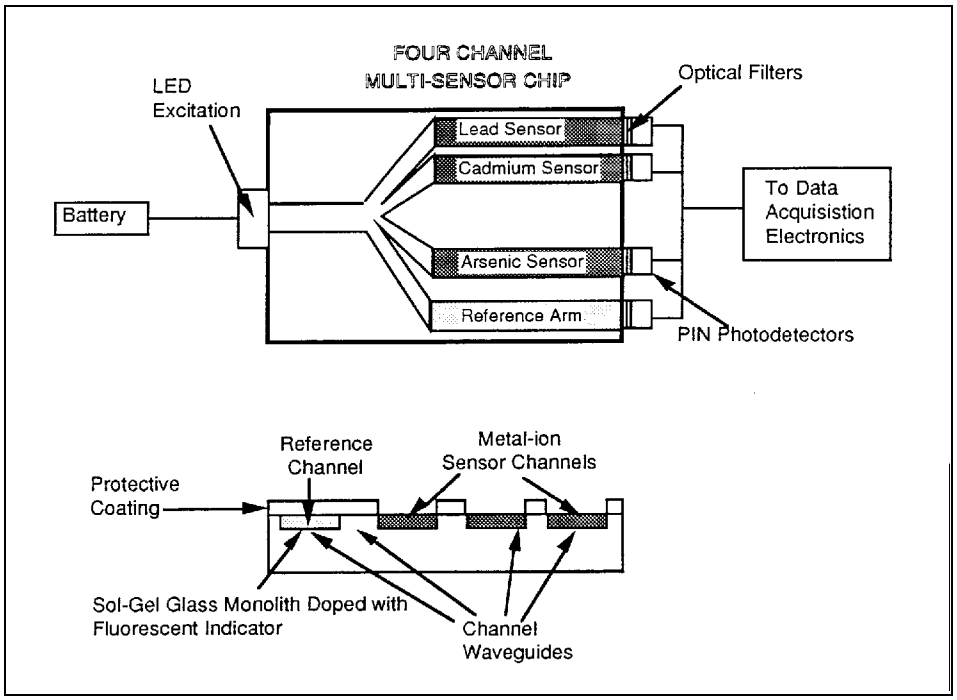
Subsurface Contaminants FOCUS AREA

Problem:

Potentially hazardous waste at Department of Energy (DOE) sites must be characterized to identify physical, chemical, and radioactive components that can interfere with treatment techniques and final waste forms. Real-time techniques are required for on-line waste processing and for effective, universal monitoring of worker exposure. Normally, hazardous waste is characterized by conventional analytical techniques that are labor-intensive for sample collection, and time-consuming with respect to laboratory work.

Solution:

The solution to this problem is a real-time, in-line analyzer, capable of simultaneously monitoring multiple analyses. When perfected, such sensors could be placed at various locations along an aqueous waste processing stream. In practice, sensors could be placed at the pump head and at several stages of treatment train; the last sensor would be placed at the effluent side of the treatment system to verify compliance with outflow requirements.



Benefits:

- In-line, continuous monitoring of hazardous waste outflow
- Self-referenced multisensing of inorganic contaminants
- Substantial cost reduction over sampling and off-site chemical analysis
- Great reduction of contaminated waste outflow

Technology:

This project developed a novel integrated optic chemical sensing (IOCS) technology for accurate in-line detection and quantification of heavy metal ions such as lead, cadmium, arsenic, chromium, copper, zinc, and nickel in hazardous waste. The IOCS sensor chip incorporates an array of chemically-active waveguides in a rugged, cost-effective unit capable of performing measurements of hazardous waste streams and other effluents in seconds.

The goal of the project was to develop a completely new multi-element sensing technology for the real-time simultaneous detection of a variety of metal ions using a single IOCS chip. The sensing chip is ruggedized to perform in situ concentration measurements and selected analyses, with a multiwavelength readout system capable of communicating these measurements to a central processing unit. The multi-element sensor unit is self contained and easy to operate, and requires minimal operator training.

The approach, based on Physical Optics Corporations strengths in integrated optics, fiber optics, and optical technology, in combination with proven chemical methodology, uses a fiber optic wavelength division demultiplexer (WDM) to analyze multiple wavelength signals, either fluorescence or absorptiometric, from a chemically active IOCS chip.

Project Conclusion:

At completion of this project the "proof-of-concept" IOCS system was successfully demonstrated. The technology developer fabricated an IOCS system and tested it by simultaneously identifying and quantifying trace amounts of inorganic contaminants in aqueous samples. It was shown that the IOCS system could be used to detect low concentration levels (~1.0 mg/l) of heavy metal ions in water.

Significant additional work is necessary to complete the development of this technology, but the technology developer was not successful in competitively proposing project completion. Therefore, the project was terminated at the end of Phase I in September 1995.

Contacts:

Physical Optics Corporation is a small business involved in developing innovative optical technologies for environmental monitoring. For information on this project, the contractor contact is:

Principal Investigator:
Dr. Edgar A. Mendoza
Physical Optics Corporation
20600 Gramercy Place, Ste 103
Torrance, CA 90501
Phone: (310) 320-3088
Fax: (310) 320-4667
E-mail: edmendoza.aol.com

DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

DOE Project Manager:
Mr. Vijendra P. Kothari
Federal Energy Technology Center
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
Phone: (304) 285-4579
Fax: (304) 285-4403
E-mail: vkotha@fetc.doe.gov